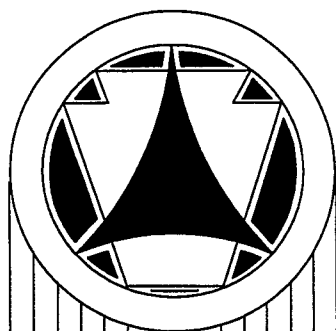




PB99-166233



**COMMONWEALTH OF PENNSYLVANIA**  
Department of Transportation

**RESEARCH PROJECT NO. 96-052**

**WIRE MESH REINFORCED EROSION  
CONTROL MAT**

**FINAL REPORT  
JUNE 1999**

**Prepared by:  
RODNEY VANSCAVISH & DARREN LEPAGE**

**PENNSYLVANIA DEPARTMENT OF TRANSPORTATION  
BUREAU OF CONSTRUCTION AND MATERIALS  
ENGINEERING TECHNOLOGY AND INFORMATION DIVISION**

REPRODUCED BY:  
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**Research Project SR 0724-03M  
Wire Mesh Reinforced Erosion Control Mat**

**FINAL REPORT**

**June 1999**

Prepared By  
Engineering District 5-0  
Geotechnical Unit

THE PENNSYLVANIA DEPARTMENT OF  
TRANSPORTATION

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## EXECUTIVE SUMMARY

This study involved evaluating the constructability and performance of a wire mesh reinforced erosion control mat, installed on SR 0724-03M, in Berks County, Engineering District 5-0. The purpose of this material, MacMat-R8, was to address a chronic erosion control problem in three areas on this project. These three problem areas exhibited soil and friable rock surfaces at a 1.4:1 slope that persistently had rocks fall onto SR 0724. Thus creating a hazard to the public and a repetitive maintenance situation for Department Forces.

The proposed plan was to obtain a single installation solution for stabilizing and re-vegetation along the slope; MacMat-R8 was the only material on the market at the time of the project that serves both desired purposes with only one installation. The wire mesh netting will hold securely any loose rock from tumbling down the slope and the erosion control mat will provide a stabilized soil surface for re-vegetation to take place.

Approximately 1733 SY of wire mesh reinforced erosion control mat, MacMat-R8, was installed at a cost of \$60,655.00 or \$35.00 / SY. Three areas that were encountered and repaired prior to placing the MacMat-R8 would have required extensive rock excavation determined to be costly. It is, therefore, anticipated that the preventative measure of installing MacMat-R8 will prove to be cost effective over time, eliminating further rock excavation due to erosion. The combined use of the two materials (the geo-mat and the steel wire mesh) in one product consistently reduces the installation costs.

There have been some minor debris found at the toe of the slope against the protective fencing at all three locations. No re-vegetation has formed due to continuous wash out and minimal exposure of sun on the slope. Maintenance costs have been significantly reduced since installation of wire mesh reinforcement erosion control mat. These three areas have been monitored from August of 1996 to January of 1999.



## METRIC CONVERSION FACTORS

TO CONVERT FROM	TO	MULTIPLY BY
<b>Length</b>		
foot (ft)	meter (m)	0.3048
inch (in)	millimeter (mm)	25.4
yard (yd)	meter (m)	0.9144
mile (statute)	kilometer (km)	1.609
<b>Area</b>		
square foot (ft <sup>2</sup> )	square meter (m <sup>2</sup> )	0.0929
square inch (in <sup>2</sup> )	square centimeter (cm <sup>2</sup> )	6.451
square yard (yd <sup>2</sup> )	square meter (m <sup>2</sup> )	0.8361
<b>Volume</b>		
cubic foot (ft <sup>3</sup> )	cubic meter (m <sup>3</sup> )	0.02832
cubic yard (yd <sup>3</sup> )	cubic meter (m <sup>3</sup> )	
gallon (U.S. liquid)**	cubic meter (m <sup>3</sup> )	0.003785
gallon (Can. liquid)**	cubic meter (m <sup>3</sup> )	0.004546
ounce (U.S. liquid)	cubic centimeter (cm <sup>3</sup> )	29.57
<b>Mass</b>		
ounce-mass (avdp)	gram (g)	28.35
pound-mass (avdp)	kilogram (kg)	0.4536
ton (metric)	kilogram (kg)	1000
ton (short, 2000 lbm)	kilogram (kg)	907.2
<b>Density</b>		
pound-mass/cubic foot	kilogram/cubic meter (kg/m <sup>3</sup> )	16.02
pound- mass/cubic yard	kilogram/cubic meter (kg/m <sup>3</sup> )	0.5933
pound-mass/gallon(U.S.)**	kilogram/cubic meter (kg/m <sup>3</sup> )	119.8
pound-mass/gallon(Can.)**	kilogram/cubic meter (kg/m <sup>3</sup> )	99.78
<b>Temperature</b>		
deg Celsius (°C)	kelvin (°K)	$t^{\circ K} = (t^{\circ C} + 273.15)$
deg Fahrenheit (°F)	kelvin (°K)	$t^{\circ K} = (t^{\circ F} + 459.67)/1.8$
deg Fahrenheit (°F)	deg Celsius (°C)	$t^{\circ C} = (t^{\circ F} - 32)/1.8$

\*The reference source for information on SI units and more exact conversion factors is the "Metric Practice Guide" ASTM E 380.

\*\*One U.S. gallon equals 0.8327 Canadian gallon.



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## **1.0 PROJECT OBJECTIVE**

The objective of this research project was to evaluate the constructability and performance of the wire mesh reinforcement erosion control mat, called MacMat-R8, in problem areas where there was persistent slope erosion. These slope areas were identified as rockfall zones along SR 0724.

The slope areas consist of soil and exposed friable rock surfaces at a 1.4:1 slope that persistently created uncertainty, of when and where the rock falls toward SR 0724 would occur. Additionally, the use of MacMat-R8 to cover the large unstabilized areas eliminated the need for performing any major rock excavating, which would have been very costly based on the height of the slope and the amount of blasting necessary to achieve the benching required to correct the problem.

## **2.0 PROJECT SITE LOCATION**

The wire mesh reinforcement erosion control mat, MacMat-R8, was used on SR 07244-03M, Berks County, Engineering District 5-0 at the following locations:

Sta. 56+00 to 56+30 (Right)

Sta. 57+25 to 57+75 (Right)

Sta. 59+00 to 59+50 (Right)

Refer to page 2 for the project location map.

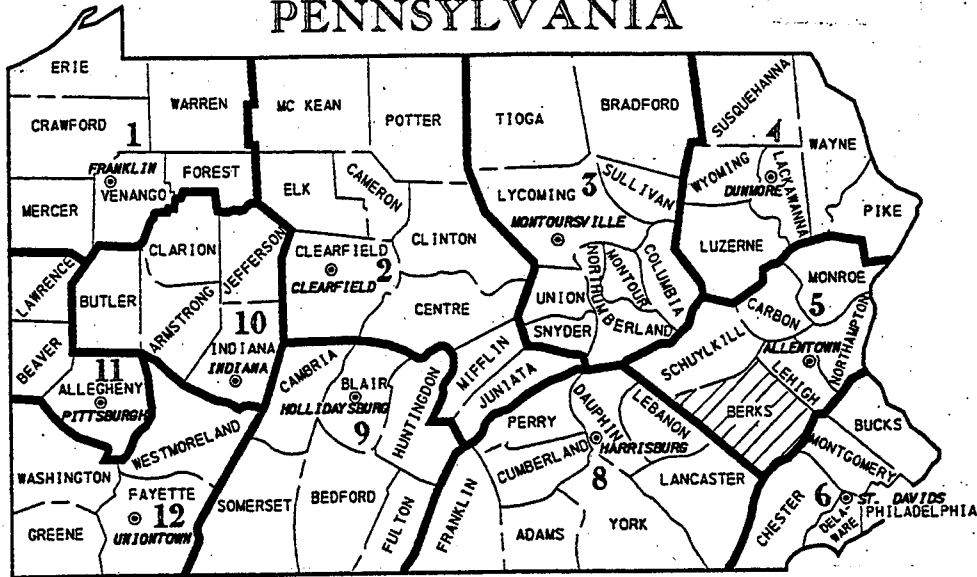
## **3.0 PROJECT DESCRIPTION**

The slopes, which are located in 3 areas exhibiting soil and friable rock surfaces at a 1.4:1 and showed signs of unstable surfaces, were covered with a wire mesh reinforced erosion control mat.

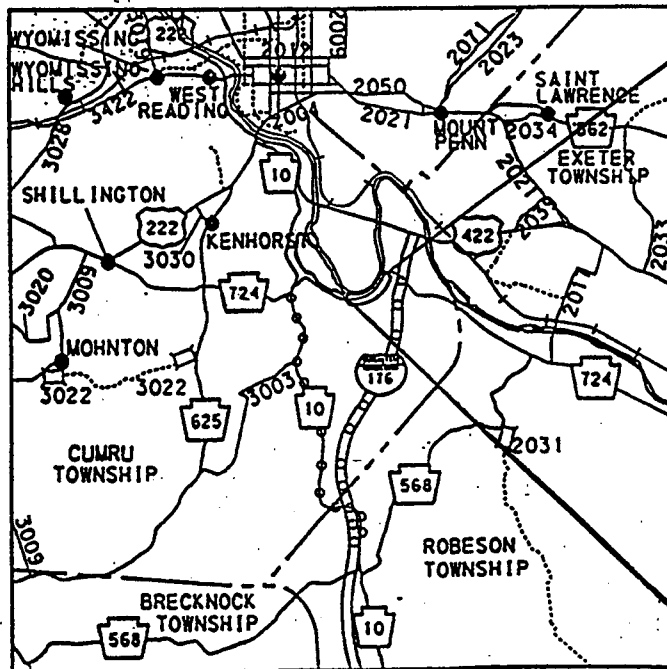
Because of the 1.4:1 slope conditions mainly consisting of fracture and loose rock surface, a single installation was needed to accommodate the field condition. The rockfall netting/erosion control mat, MacMat-R8, was sufficient to address the existing conditions. The MacMat-R8 with anchor bolts was used to secure the material to the slope. This was the only material currently on the market at the time of the project, which could correct both problems with a single installation.

# Location Map

## PENNSYLVANIA



© DISTRICT OFFICE



### LEGEND

- ===== LIMITED ACCESS HIGHWAY
- ===== STATE ROUTE & TRAFFIC ROUTE
- TOWNSHIP ROAD
- ===== PROJECT
- DETOUR

### SCALE

0 1 2 3 MILES

### LIMIT OF WORK

STA. 74+50  
SEG. 240 OFFSET 139  
S.R. 724 SEC. 03M  
CUMRU TOWNSHIP  
BERKS COUNTY

### LIMIT OF WORK

STA. 49+30  
SEG. 250 OFFSET 70  
S.R. 724 SEC. 03M  
CUMRU TOWNSHIP  
BERKS COUNTY



#### **4.0 MATERIAL DESCRIPTION**

The MacMat-R8 material used on this project was supplied by Maccaferri Gabions, Inc., 10303 Governor Lane Blvd., Williamsport, Maryland, 21795-3316.

The MacMat-R8 is a wire mesh reinforced erosion control mat, which consists of a double twist steel wire mesh inside a three-dimensional geo-mat. The double twist wire mesh protects the geo-mat for any potential damage occurring during the installation and confines any damage that may occur in service, to a single mesh opening.

The properties and specifications for the MacMat-R8 can be found in Appendix B and Appendix C.

#### **5.0 CONSTRUCTION PROCEDURES**

The contractor utilized five (5) working days to complete clearing and grubbing along with installation of the wire mesh reinforced erosion control mat at all of the designated locations throughout the project.

The construction operation consisted of one superintendent, one operator and three laborer/truck drivers for installation. The clearing and grubbing labor force consisted of one foreman and three (3) laborers.

The equipment required to complete this project was as follows: one backhoe, one tree chipper, two chainsaws, one flat bed truck, one pickup truck with winch system, one air stapler, and air drill for anchoring devices. Additionally, the three men working on this slope needed to use special equipment, like a climbing harness with a "D" ring and rope, in order to work safely, see photographs 3 and 4.

The wire mesh reinforced erosion control mat was installed by clearing and grubbing the slope areas using chain saws. The weight of the material required a winch system connected to a pick-up and pulley system anchored on top of the slope. The MacMat-R8 rolls were pulled up the slope by a cable from the pulley system. Once the rolls were stabilized at the top of the slope, the air stapler was utilized to connect the rolls with galvanized staples for vertical and horizontal joints at 6-inch center to center. The rolls were unrolled down the slope simultaneously with the anchor drilling ahead of the operation following a 6-foot by 12-foot pattern. The anchor bolts were installed immediately following the unrolling and positioning of the MacMat-R8. Typically the MacMat-R8 rolls were 6 foot in width and cut to fit for length. Refer to Figure 1, Figure 2 and Figure 3 for MacMat-R8 layout and details. The bottom end of the MacMat-R8 was buried under #57 stone behind the barrier with cold galvanizing spray applied to lowest row of anchor bolts on all sections of wire mesh erosion control mat. Finally, special formula seeding and soil supplements were applied to the slope areas to promote vegetation to propagate.

## **6.0 CONSTRUCTION COSTS**

The actual material cost for the wire mesh erosion control mat was about \$9.60/SY. The contractor's bid price, including installation, was \$35.00/SY. The entire installation cost was approximately \$60,655.00 to place an estimated quantity of 1733 SY of material.

## **7.0 CONCLUSIONS**

To date only minor debris was removed at the location where the wire mesh reinforced erosion control mat was installed as noted. The minor debris was located at the toe of the slope behind the rock protection fence. Monitoring of these sites has continued since completion of installation. No vegetation has developed due to the severity of slope and lack of sunlight.

For maintenance purposes, the #57 stone behind the barrier, at the toe of the slope, should be lower to allow for potential buildup of debris over time. Also, the rock fence sitting on top of the barrier should be installed with shorter removable sections, allowing easier debris removal by Department Maintenance Forces.

## **8.0 RECOMMENDATIONS**

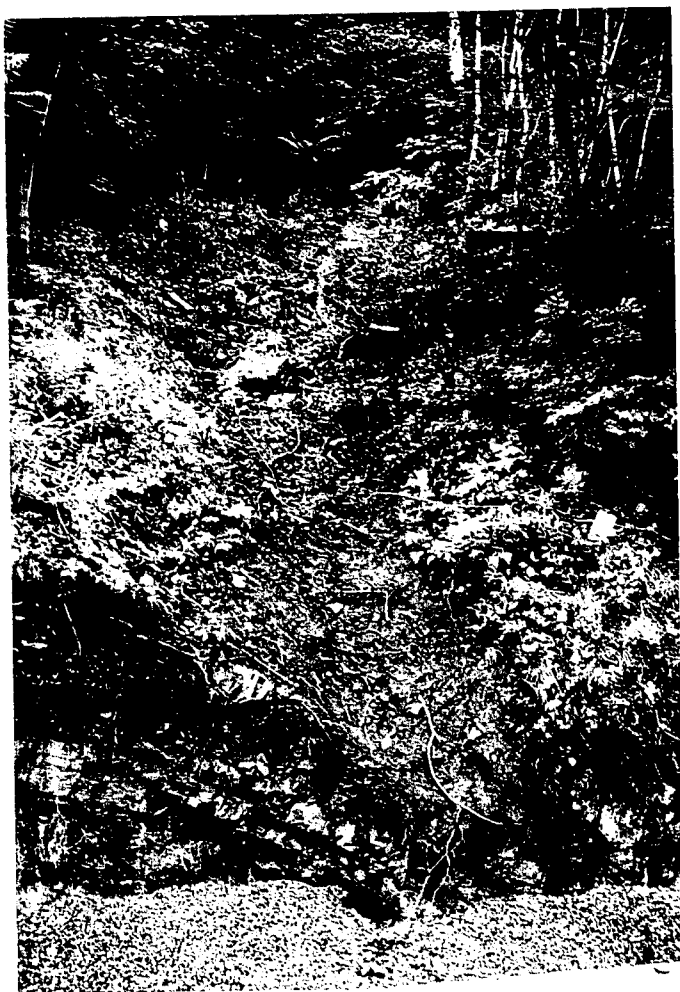
MacMat-R8 is recommended for approval once the material meets Act 3 requirements and is fabricated from domestic steel. It is recommended that in the future, under similar circumstances, no topsoil and seed be incorporated. The attempt to vegetate a similar north face slope would be futile due to the steep slope and lack of sunlight.

## **APPENDIX A - PHOTOGRAPHS**

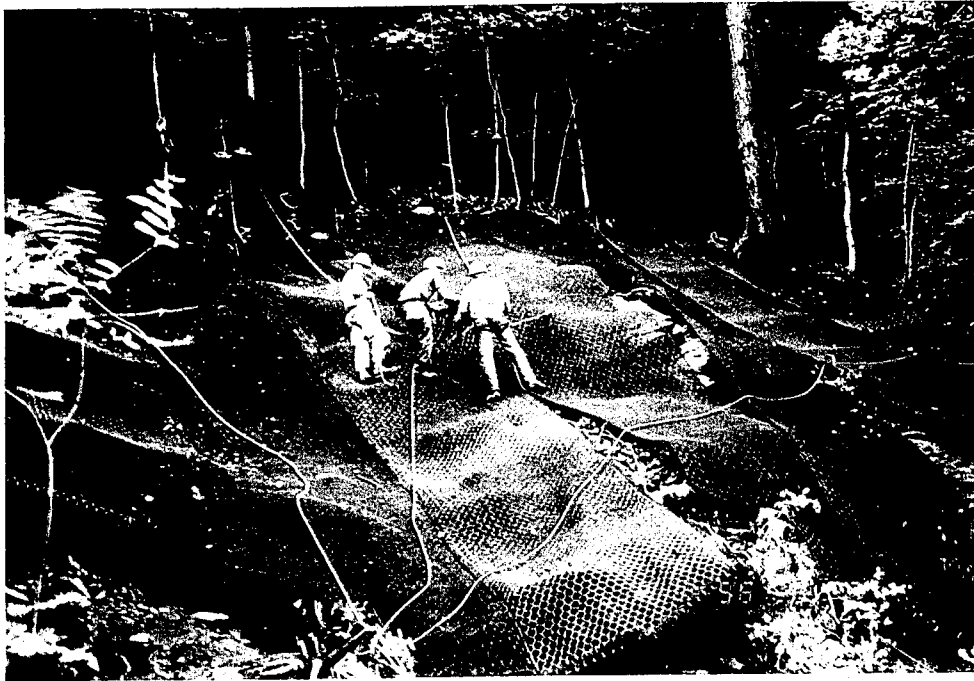




**Photograph No. 1** – View of slope before construction.



**Photograph No. 2** – View of slope before wire mesh implementation.



**Photograph No. 3** – Placement of wire mesh in September 1996 by men wearing mountain climbing equipment.



**Photograph No. 4** - Shows implementation of wire mesh reinforced erosion control mat in September 1996.



**Photograph No. 5** – Showing some debris on the slope after construction.



**Photograph No. 6** – Showing  
slop after construction.



**Photograph No. 7** – Shows site in April 1998 with little vegetation.

**Photograph No. 8** – Showing site in April 1998 with sparse vegetation.





## **APPENDIX B – MACMAT-R8 TECHNICAL SHEET**



# MacMat<sup>®</sup> - R8

Erosion Control Geomat For Permanent Revegetation

## TECHNICAL SHEET

MacMat<sup>®</sup> - R8 is a composite material consisting of a three dimensional geomat made of polypropylene monofilaments which is integrated during the manufacturing process with Maccaferri double twisted hexagonal 8x10 type mesh.

	ITEM	STANDARD	UNITS	MacMat <sup>®</sup> -R8G	MacMat <sup>®</sup> - R8P
POLYMER PROPERTIES	Polymer Type	--	--	Zinc	Zinc + PVC
	Density	ASTM D792	g/m <sup>3</sup>	Polypropylene	
	Melting Point	ASTM D1525/1505	°C	900	
	Color	--	--	150	
	U. V. Resistance	ASTM D4355	--	Black Stabilized	
ROLL SIZE	Width	--	m	2	2
	Length	--	m	25	25
	Weight	--	kg	106	118
MacMat PROPERTIES	Thickness	ASTM D1777	mm	20	20
	Unit Weight	ASTM D3776	g/m <sup>3</sup>	2120	2360
	Tensile Strength of MacMat <sup>®</sup> - R8	ASTM D4595	kN/m	43	43
	Upper Void Space	--	%	90	90
MESH PROPERTIES *	Mesh Type	--	--	8x10	8x10
	Mesh Opening (Nom.)	--	mm	80 x 100	
	Edge Wire Dia. (Nom.)	ASTM A641	mm	3.40	4.20
	Mesh Wire Diameter	--	--	2.70	3.50
	Zinc Coating	ASTM A641	g/m <sup>2</sup>	245	245
	PVC Nominal Thickness	--	mm	N/A	0.55
	PVC Minimum Thickness	--	mm	N/A	0.38
	Wire Tensile Strength	ASTM A641	kg/mm <sup>2</sup>	42-50	42-50
	Mesh Tensile Strength	--	kN/m	43	43

**Tolerance** Roll length: 1%, Roll width: 4%

\* For complete specifications concerning the mesh reinforcement, please refer to the back of this sheet for Maccaferri double twisted hexagonal mesh specifications.

Note: MacMat<sup>®</sup> - R8 is available with other thicknesses and Maccaferri mesh configurations on request.

The information contained in this technical sheet is furnished without charge or obligation and the recipient assumes all responsibilities for its use. The data is to the best of our knowledge true and correct. However, no warranties are expressed or implied and the results published are subject to change at any time without notice.



## **APPENDIX C – MACMAT-R8 TYPE SPECIFICATIONS**



# MacMat® - R8

## Maccaferri Wire Mesh 8x10 Type Specification.

### 1. Woven Wire Mesh.

- Galvanized steel wire, Class 3 coating, soft temper tensile strength, in accordance with ASTM A641-92.
- Elongation - Not less than 12% in accordance with ASTM A370-92.

### 2. PVC (Polyvinyl Chloride) Coating. (When specified in the plans)

- Color - Gray
- U. V. Resistance - According to ASTM D1499-92A and ASTM G23-93, 3000 hours.
- Salt Spray Test - According to ASTM B117-93, 3000 hours.
- Abrasion Resistance - According to ASTM D1242-93. Weight loss not more than 0.19g.

### 3. Ring Wire Fastener.

Ring wire fasteners are used when connecting adjacent rolls. The spacing of the fasteners shall not exceed 15 cm. (6 inches).

- Galvanized Rings - 3.05mm (0.120 inch) diameter, 230,000 to 273,000 psi tensile strength. Tensile strength and coating in accordance with ASTM A764-93.
- Stainless Steel Rings (for PVC coated mesh) - 3.05mm (0.120 inch) diameter, 222,000 to 253,000 psi tensile strength. Type 302, Class 1 in accordance with ASTM A313-92 Table 1-2.
- Load Test shall conform to ASTM A370-92. Tensile strength shall be determined per ASTM E8/ MTP 2004-94.

### 4. Tolerances.

- Wire: In accordance with ASTM A641-92, Table 3.
- 8x10 Mesh: 4% on the width and 1% on the length of the rolls.
- 6x8 Mesh: 3% on the width and 1% on the length of the rolls.



**MACCAFERRI GABIONS, INC.**  
10303 GOVERNOR LANE BLVD.  
WILLIAMSPORT, MD. 21795-9602  
TELEPHONE: (301) 223-6910  
FAX: (301) 223-6134

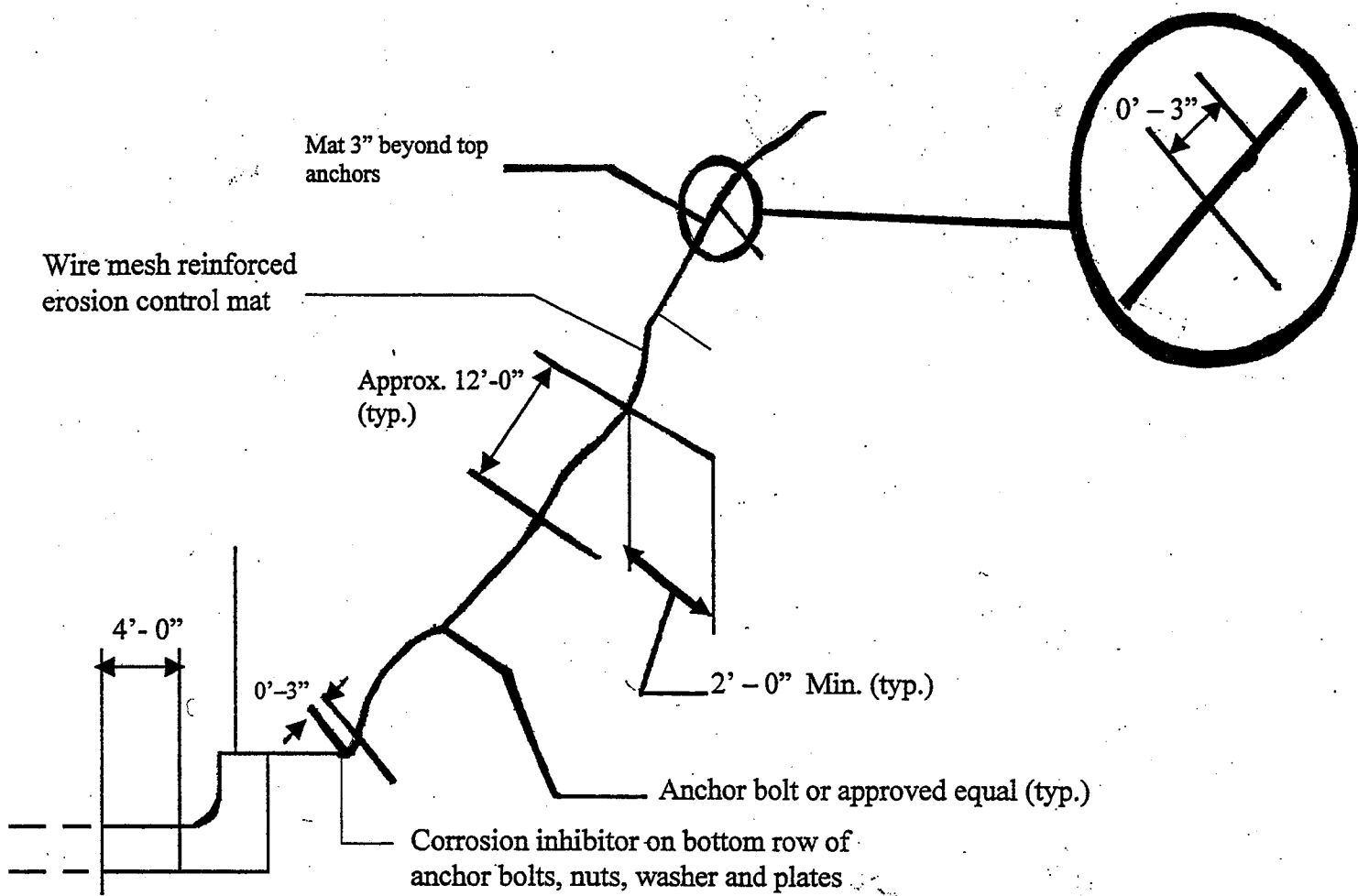
**MACCAFERRI GABIONS, INC.**  
3650 SEAPORT BLVD.  
WEST SACRAMENTO, CA 95691-0410  
TELEPHONE: (916) 371-5805  
FAX: (916) 371-0764





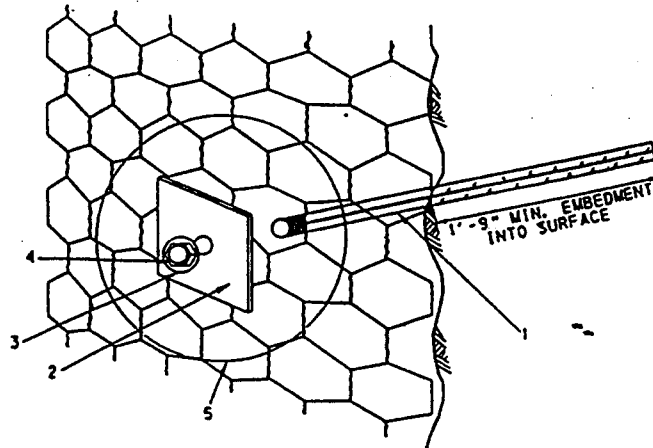
## **APPENDIX D - FIGURES**





**Figure 1 CROSS-SECTION OF WIRE MESH REINFORCED EROSION CONTROL MAT ANCHORING**

Figure 2

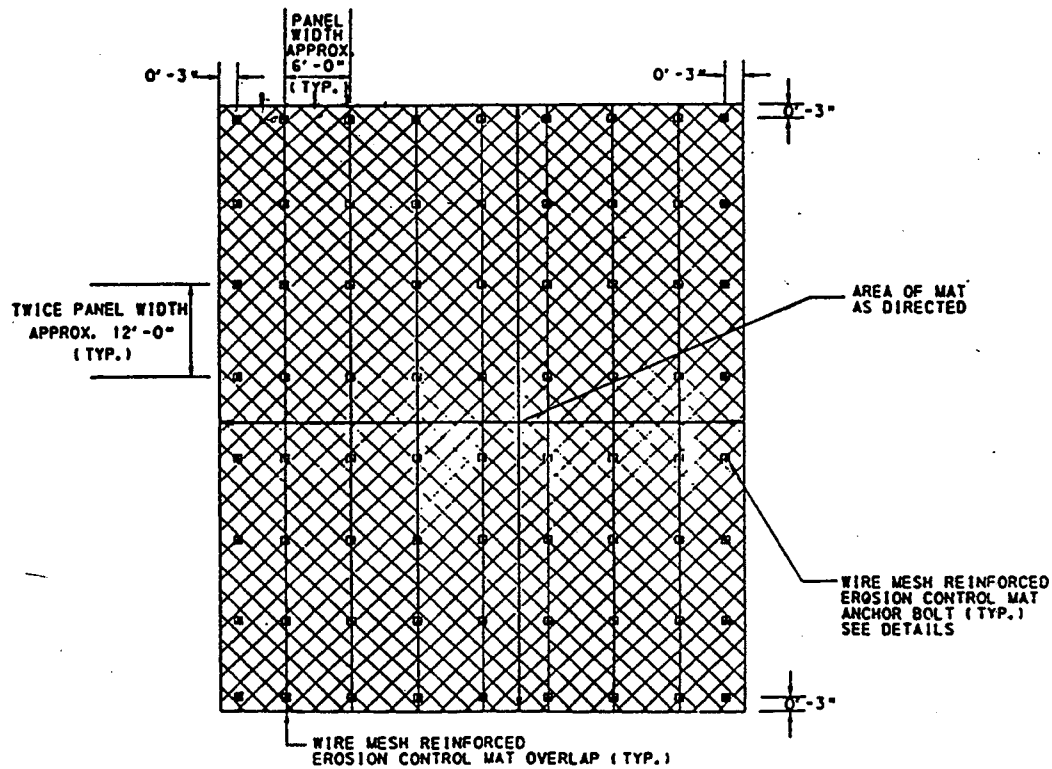


**ANCHOR BOLT DETAIL**

1. 1" DIA. ANCHOR BOLT (2" MIN. THREADED)
2. 5" X 5" X 1/4" STEEL PLATE (A36)
3. BEVELED STEEL WASHER, 2" DIA.
4. STANDARD HEX NUT
5. GREASE

NO SCALE

Figure 3



**WIRE MESH REINFORCED EROSION CONTROL MAT**

ITEM NO. 9000-0003

Note: No Mutching-Hay and Mulch Control Netting required for area of Mat  
Apply Seeding and Soil Supplements-Special Formula after Installation of Mat.